Solar America Initiative

Technical Improvement Opportunities

SOLAR AMERICA INITIATIVE

Breakout Session Agenda

- Introduction of Facilitator/Scribe
- Breakout group introductions: name and organization
- Session setup/ground rules
  - Purpose
  - Non-purpose
- Overview presentation of topic
- ID representative for report-out
- Discuss questions
- Summarize

Purpose of Breakout Session

- Discussion of critical issues that will have a significant impact on the structure of the initiative and the resulting solicitation.

Session Non-Purpose: Topics not discussed or debated:

- Specific answers to questions posed by participants
- Provide information on the DOE procurement process
- DOE Solar budget or current program structure
- DOE Administration policy decisions
- Proprietary corporate or organizational information
- Sales or marketing speeches for participants' companies
- Present unverified technical data or assertions

Objectives of this Breakout Session

- Present framework for technical requirements within SAI
- Discuss program analyses with Solar Advisor Model
- Discuss appropriate level of detail for tech. requirements
- Solicit feedback on tracking of metrics and progress towards program goals.

Review of Overall Program Goals

Market Sector	Current U.S. Market Price Range (¢/kWh)[1,2]	Cost (¢/kWh)[1]		
		Benchmark	Target	
		2005	2010	2015
Residential	5.8-16.7	23-32	13-18	8-10
Commercial	5.4-15.0	16-22	9-12	6-8
Utility	4.0-7.6	13-22	10-15	5-7

[1]Prices are based on constant 2005 dollars.
[2]Current prices are based on electric-generation with conventional sources.

- Market goals based on conventional grid-tied sources
- Highest-penetration markets selected as focus
- Targets expressed as system *levelized cost of energy*

Technical Improvement Opportunities

TIOs		Metrics			
TIER 1 TIOs	TIER 2 TIOs	Performance/ Efficiency	Cost	O&M	Reliability
1. Modules	Module				
	Absorber				
	Cells and Contacts				
	Interconnects				
	Packaging				
	Manufacturing				
2. Inverters and BOS	Inverter				
	Inverter Sftware				
	Inverter Components/Design				
	Invtr Packaging/Manufacturing				
	Inverter Integration				
	Other BOS				
3. Systems Engineering & Integration	Systems Engr & Int.				
	System Manufacturing/Assembly				
	Installation and Maintenance				
4. Deployment Facilitation					

- Color boxes indicate degree of impact that TIO has on each metric and overall levelized cost of energy. (high, medium, low)

"Typical" PV Systems in Target Markets

- Residential
  - Generally roof-mounted, 1-10kW in size
  - Most commonly 3-4kW
  - Retail side of electric meter
- Commercial
  - Large, flat rooftop installations (warehouses, factories, etc.)
  - Generally 10-500kW in size
  - Possible structural integration (BIPV)
  - Retail side of electric meter
- Utility
  - Typically 1 to 10MW or larger
  - Ground-mounted, fixed or tracking
  - Flat plate or concentrating PV
  - Utility side of electric meter
- Of course, there are many variations on these characteristics

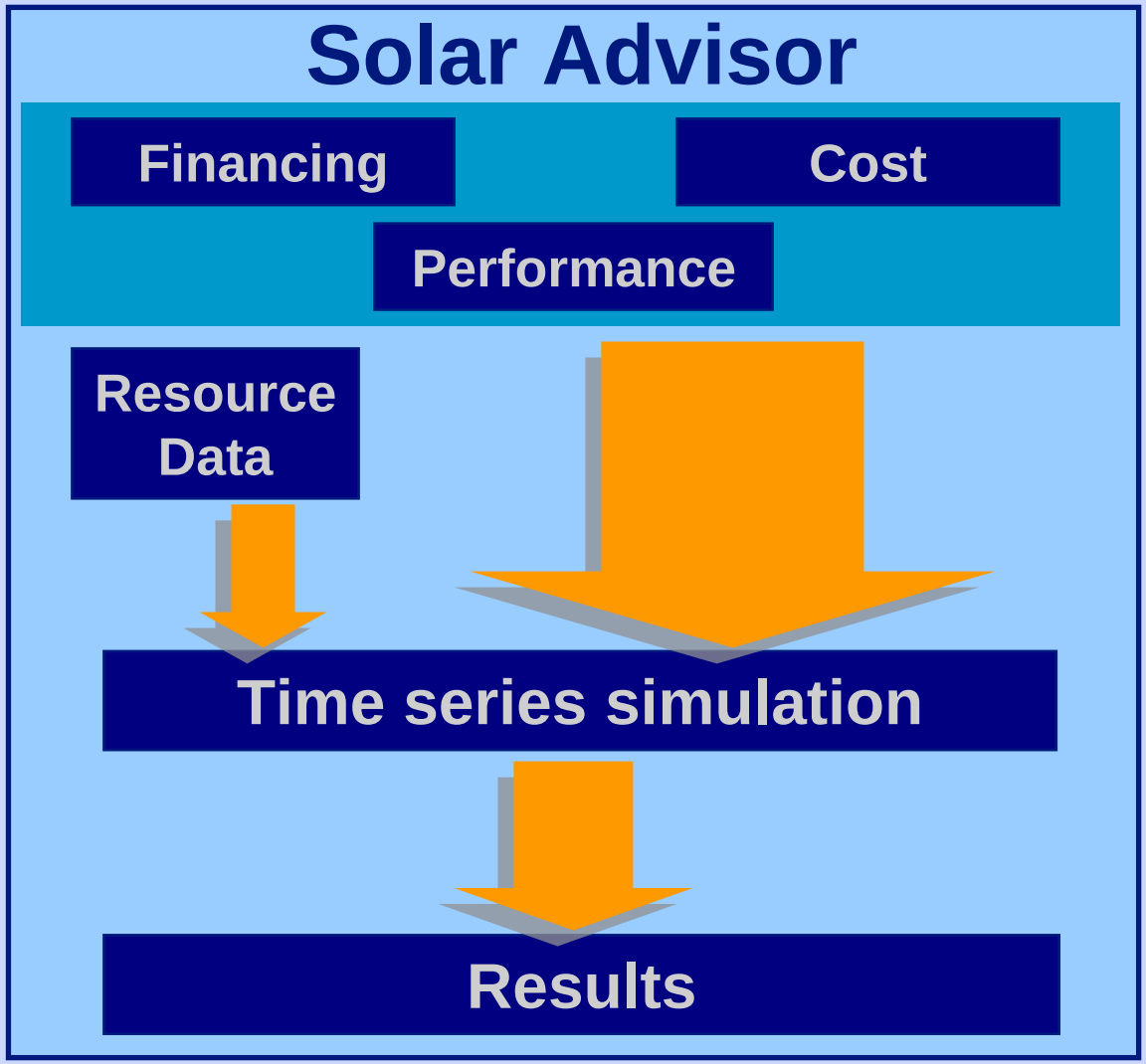
Model Structure

User inputs required for:

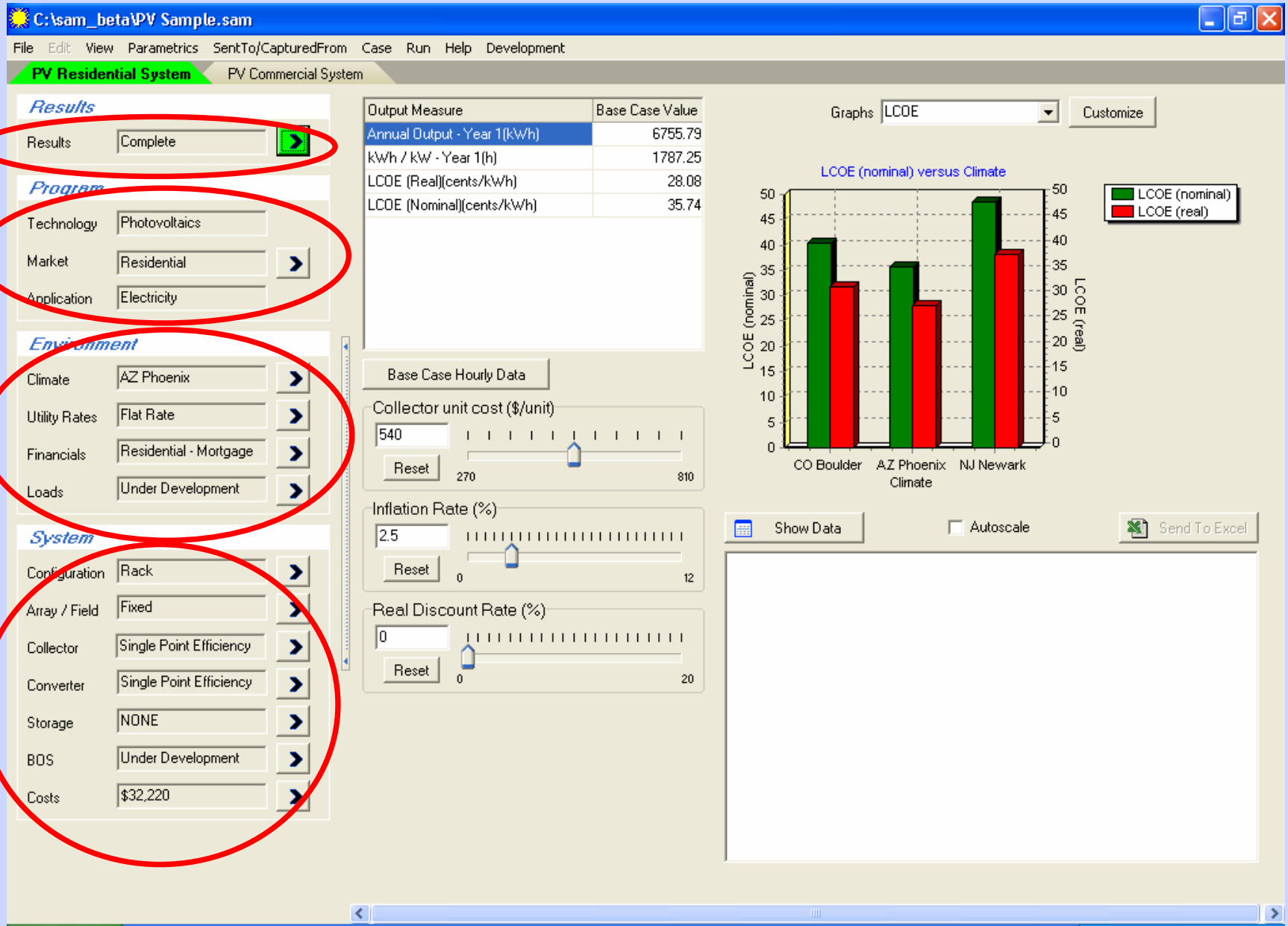
- Technology/market selection
- Climate (location)
- Financial assumptions
- System performance and configuration
- System cost

Results include but not limited to:

- Annual output based on hourly simulation
- Cash flow over project life
- Levelized cost of energy (real and nominal)

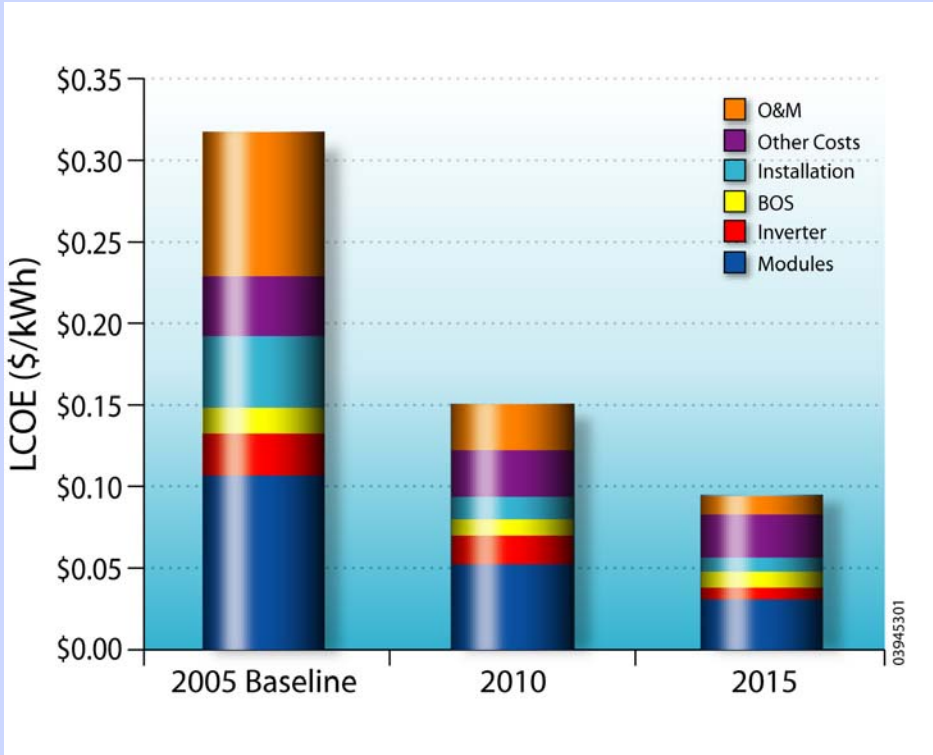


SAM Inputs and Results



Residential System Requirements

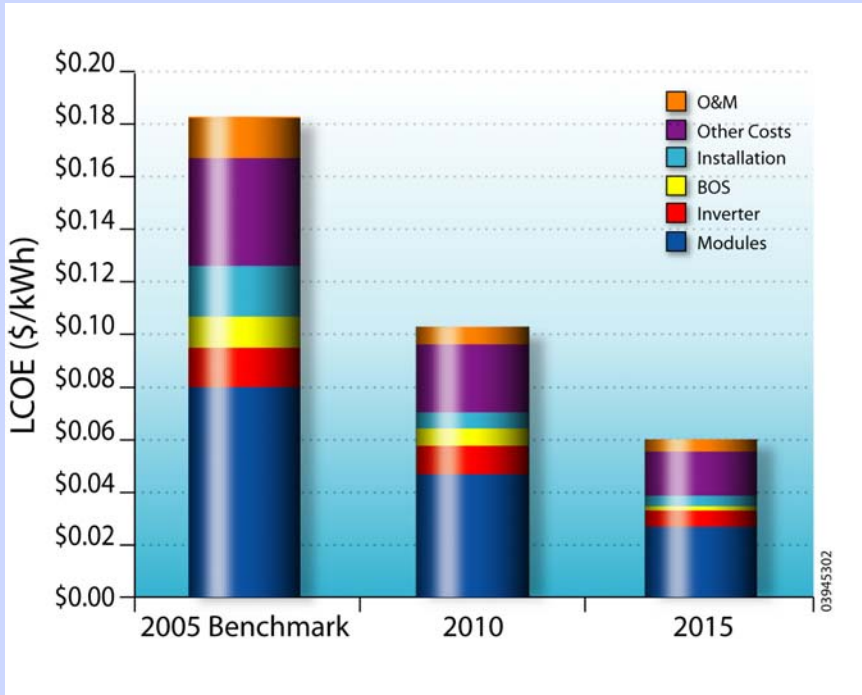
Residential System Element	Units	2005 Benchmark Value	2010 Target	2015 Target
Performance Parameters				
Module Efficiency	%	13.5	16	20
Inverter DC-AC Conversion Efficiency	%	90	96	97
Annual System Degradation	%	1	1	1
Cost Parameters				
Module	$/Wpdc	4.00	2.20	1.25
Inverter	$/Wp	0.90	0.69	0.30
Other Balance of Systems	$/Wpdc	0.61	0.40	0.33
Installation	$/Wpdc	1.66	0.57	0.42
Other*	$/Wpdc	1.30	1.14	1.00
INSTALLED SYSTEM PRICE	$/Wpdc	8.47	5.00	3.30
Reliability and O&M Parameters				
Inverter Lifetime – Replacement Cycle	Years	5	10	20
Module and Overall System Lifetime	Years	30	35	35
Annual O&M Cost (not incl. inverter replacement)	% installed system price	0.5	0.3	0.2
Calculated LCOE	$/kWhac	**0.32**	**0.15**	**0.09**



- This level of detail in cost, performance, and reliability data will be required in proposals
- As will underlying justification for the numbers.

Commercial System Requirements

Residential System Element	Units	2005 Benchmark Value	2010 Target	2015 Target
Performance Parameters				
Module Efficiency	%	13.5	16	20
Inverter DC-AC Conversion Efficiency	%	90	96	97
Annual System Degradation	%	1	1	1
Cost Parameters				
Module	$/Wpdc	3.50	2.20	1.25
Inverter	$/Wp	0.60	0.51	0.25
Other Balance of Systems	$/Wpdc	0.54	0.36	0.08
Installation	$/Wpdc	0.55	0.47	0.42
Other*	$/Wpdc	1.10	0.76	0.50
INSTALLED SYSTEM PRICE	$/Wpdc	6.29	4.00	2.21
Reliability and O&M Parameters				
Inverter Lifetime – Replacement Cycle	Years	10	15	20
Module and Overall System Lifetime	Years	30	35	35
Annual O&M Cost (not incl. inverter replacement)	% installed system price	0.45	0.3	0.2
Calculated LCOE	$/kWhac	**0.18**	**0.10**	**0.06**



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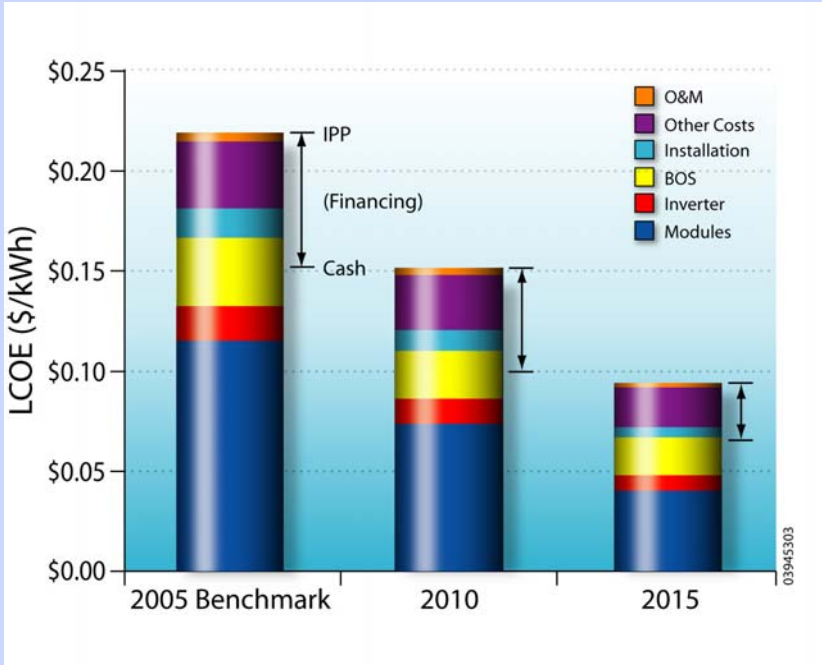
Utility-scale System Requirements

Residential System Element	Units	2005 Benchmark Value	2010 Target	2015 Target
Performance Parameters				
Module Efficiency	%	13.5	16	20
Inverter DC-AC Conversion Efficiency	%	90	96	97
Annual System Degradation	%	1	1	1
Cost Parameters				
Module	$/Wpdc	3.30	2.20	1.25
Inverter	$/Wp	0.46	0.35	0.25
Other Balance of Systems	$/Wpdc	0.97	0.73	0.61
Installation	$/Wpdc	0.27	0.16	0.10
Other*	$/Wpdc	0.55	0.46	0.37
INSTALLED SYSTEM PRICE	$/Wpdc	5.55	3.90	2.58
Reliability and O&M Parameters				
Inverter Lifetime – Replacement Cycle	Years	10	15	20
Module and Overall System Lifetime	Years	30	35	35
Annual O&M Cost (not incl. inverter replacement)	% installed system price	0.15	0.1	0.1
Calculated LCOE	$/kWhac	**0.15-0.22**	**0.10-0.15**	**0.06-0.09**



- This level of detail in cost, performance, and reliability data will be required in proposals
- As will underlying justification for the numbers.

Select Representative for Report-Out

Guiding Questions

- Can you design target systems and formulate an R&D project plan within the TIO systems engineering framework?
  - What obstacles do you see, based on the TIO structure and the example performance parameter "requirements" cited before?
- How well does the *TIO structure* fit your approach to the PV value chain?
  - In R&D task planning?
  - In manufacturing and integration operations?
- How well does *LCOE as a metric* fit your approach to the PV value chain?
  - In R&D task planning, manufacturing and integration operations?
  - Are there additional key metrics that are not covered by LCOE?
- What issues do you anticipate in DOE's use of SAM as a tool to aid project evaluation?
- Brainstorm on types of "deliverables" to provide for assessment of progress – hardware for lab tests, field evaluations, analysis reports, etc.